PSYCHE.

THE PRIMITIVE NUMBER OF MALPIGHIAN VESSELS IN INSECTS.— III.

BY WILLIAM MORTON WHEELER, PH.D., CHICAGO, ILL.

ORTHOPTERA. It is in this order that we first meet with facts having a decided bearing on the question under consideration. I have no data on the embryology of the Phasmidae and Mantidae.* The other families may be taken up in order.

BLATTIDAE. In the embryo *Phyllodromia germanica* I find four Malpighian vessels which arise as discrete outgrowths of the hind-gut in the manner so often described for other insects. Somewhat later two more vessels are added. The adult Phyllodromia and *Periplaneta orientalis* have 60–70 vessels according to Schindler† and Miall and Denny.‡ Hence a great increase in the number of tubules must take place during larval life. That this is the case was shown by Schindler,§ who found only 16–18 vessels in a larval Periplaneta not quite 10 mm. long, and only eight vessels in larvæ measuring 4-5 mm. Notwithstanding this increase in the number of vessels, the number (6) persists throughout life, since, as Miall and Denny* have shown, the vessels of the adult are grouped in six clusters at the anterior end of the strikingly hexagonal rectum.

LOCUSTIDAE. In the embryo *Xiphidium ensiferum* four Malpighian vessels arise as in Blattids; to these a third pair is soon added. In the adult, of which I examined four specimens, the vessels are inserted in six clearly defined clusters, each containing about 7 or 8 tubules. Hence there can be no doubt that in this form also the number of vessels increases during larval life. This increase is probably effected by a budding out of new vessels from the proctodaeal wall at the bases of the embryonic vessels. A large adult Orchelimum which I examined showed the same arrangement of Malpighian vessels as Xiphidium.

Other writers have observed the clustered arrangement of the excretory tubules in the Locustidae but they fail to find six clusters. According to Leon Dufour† the 10–12 vessels of Ephippigera open into the gut on five sepa-

* Leon Dufour. Recherches sur les Orthoptères etc., p. 358, claims the number of Malpighian vessels in the adult Mantis to be "une centaine environ."

† l. c. p. 607.

‡ The structure and life-history of the cockroach (Periplaneta orientalis) London, 1886, p. 128.

§ l. c. p. 607.

* l. c. 123.

† l. c. p. 350.

rate knob-like projections. According to Schindler,* *Locusta viridissima* has more than 100 vessels; "sie münden zwar bei *L. viridissima* einzeln in den anfangstheil des dünndarms ein, haben sich aber dabei—entsprechend dem familiencharakter—deutlich in 4 oder 5 ziemlich umschriebene büschel gruppiert." Schindler† also studied *Decticus verrucivorus*. "Die absonderung dieser organe in einzelne (vier) büschel ist bei Decticus weniger auffallend, als bei Locusta." I venture to conclude either that Dufour and Schindler have overlooked one or two of the clusters of vessels or, what is more probable, that the forms which they studied presented a fusion of two or more of the primitive clusters.

Gryllidae. The Malpighian vessels of this group present a very aberrant character; most, if not all, the forms having in their adult condition a great number of tubules opening into the rectum by means of a single long duct. Schindler‡ estimates the number of vessels in *Acheta campestris* at about 100.

Rathke§ studied the embryonic conditions in Gryllotalpa and found that the embryo leaves the egg with only four vessels, which, even at this time, are connected with the proctodaeum by means of a single duct. Soon another pair of vessels is added, so that we really have a stage with six vessels, albeit united in a single cluster. More vessels are acquired from time to time during larval life, till the imaginal number is completed.

Oecanthus niveus apparently presents more primitive conditions. Ayers,* who studied the embryology of this insect, makes the following statement. "When the tube (proctodaeum) has elongated so that its enlarged end lies within the fourth or fifth segment of the abdomen (counting from behind forwards) there arises near the free end in the median dorsal line a small trilobed, hollow bud of the ectodermic layer, opening into the lumen of the tube. Each lobe grows rapidly into a small tubular organ, the primitive Malpighian vessel. Each of these bifurcates at some distance from the proctodaeum, so that there are ultimately six of the tubes." This account certainly tends to show that in some Gryllids 3 and 2 are combined in the primitive number. The common duct seen in Gryllotalpa and Acheta and indicated in the embryo Oecanthus may, I believe, be safely regarded as a secondary development, since it occurs in no other group of Orthoptera and but very rarely appears in other orders.

Acridiidae. The numerous Malpighian vessels in this family resemble those of the Locustidae but are not arranged in clusters. In the embryo *Melanoplus femur-rubrum* I find only six vessels, originating simultaneously in three pairs.

*l. c. 619.

† l. c. p. 621.

‡ l. c. p. 616.

§ Zur entwicklungsgeschichte d. maulwurfsgrille. Müller's archiv. 1844, p. 27, taf. ii, fig. 435.

* On the Development of Oecanthus niveus and its parasite Teleas. Mem. Bost. soc. nat. hist. vol. iii, 1884, p. 246.